Decision Report

Application for Licence Amendment

Division 3, Part V *Environmental Protection Act 1986*

Licence Number	L5029/1992/11
Licence Holder	Northern Star (Kanowna) Pty Limited
ACN	010 511 789
File Number	DER2018/000241
Premises	Kanowna Belle Gold Mine Mining tenements: M27/18, 22, 23, 37, 49, 57, 92, 103, 122, 12 127, 159, 164, 232, 245, 287, 420 and L27/87, 83, 62 KANOWNA WA 6431
Date of Report	27 June 2019
Status of Report	Final

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1. Definitions of terms and acronyms

In this Decision Report, the terms in Table 1 have the meanings defined.

Table 1: Definitions

Term	Definition
ACN	Australian Company Number
AHD	Australian Height Datum
ANCOLD	Australian National Committee on Large Dams Incorporated
ANZECC	Australia and New Zealand Environment and Conservation Council
ARI	Average Recurrence Interval is the occurrence of total rainfall exceeding a value over a given time period
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
Category/ Categories/ Cat.	Categories of Prescribed Premises as set out in Schedule 1 of the EP Regulations
CS Act	*Contaminated Sites Act 2003* (WA)
Decision Report	refers to this document.
Delegated Officer	an officer under section 20 of the EP Act.
Department	means the department established under section 35 of the *Public Sector Management Act 1994* and designated as responsible for the administration of Part V, Division 3 of the EP Act.
DWER	Department of Water and Environmental Regulation
EP Act	*Environmental Protection Act 1986* (WA)
Existing Licence	L5029/1992/11
Licence Holder	Northern Star (Kanowna) Pty Ltd
m^3	cubic metres
mbgl	Meters below ground level
MS	Ministerial Statement
mRL	Reduced Level is the lateral elevation height in meters. In the current report this value is equivalent to height above mean sea level.
mtpa	million tonnes per annum
Noise Regulations	*Environmental Protection (Noise) Regulations 1997* (WA)
Occupier	has the same meaning given to that term under the EP Act.
Prescribed Premises	has the same meaning given to that term under the EP Act.

Premises	refers to the premises to which this Decision Report applies, as specified at the front of this Decision Report
TSF	Tailings Storage Facility

2. Purpose and scope of assessment

This amendment is made pursuant to section 59 of the *Environmental Protection Act 1986* (EP Act) to amend the Licence issued under the EP Act for a prescribed premises as set out below. This notice of amendment is given under section 59B(9) of the EP Act.

This notice is limited only to an amendment for Category 5: processing or beneficiation of metallic or non-metallic ore. No changes to the aspects of the original Licence relating to Category 6: mine dewatering or Category 44: metal smelting or refining have been requested by the Licence Holder.

The guidance statements that have informed the decision are listed in Appendix 1.

2.1 Amendment description

Northern Star (Kanowna) Pty Limited ("Northern Star") lodged an application to Amend Licence L5029/1992/11 to allow for the operation of new Tailings Storage Facility (TSF) 2 at the Kanowna Belle Gold Mine on 3 May 2019. Appendix 1 contains a list of the documents that form the application.

Northern Star were issued with Works Approval W6125/2018/1 on the 15 May 2018 for the construction and operation of TSF 2 starter embankment only to al height of 355mAHD. The DWER received the final documentation demonstrating completion of the construction of the starter embankment height of 355m AHD on 5 May 2019. The two celled paddock style compound has a foot print of 100Ha and lies north and immediately adjacent to the existing TSF 1 and will allow for the storage of approximately 20 million tonnes of tailings and extend the life-of-mine by approximately 10 years.

Other works completed under Works Approval W6125/2018/1 included the construction of TSF associate infrastructure such as an underdrainage system, decant tower, pipelines, piezometers, a return water pond and a cyanide destruction plant. The works also included the decommissioning of 70 historical exploration bores, 10 groundwater monitoring well and 7 seepage recovery bores in the TSF footprint; the construction of 15 new monitoring bores surrounding TSF 2 and construction of stormwater drainage and diversion channels surrounding the TSF. The subsequent embankment raises (stages1-6 with a final height of 370mAHD) have not been assessed as part of W6125/2018/1 or this amendment.

This amendment includes changes to the ambient groundwater monitoring bores in accordance with the construction (inclusion) and decommissioning (removal) of bores surrounding TSF1 and TSF2 from the Licence conditions; but also an alteration to the frequency of monitoring surrounding TSF's that have already reached capacity and will no longer be used once TSF2 is commissioned other than for emergency storage of supernatant.

The primary environmental pollution control mechanism for the operation of the TSF is the construction in accordance with the methods and using the materials and design specifications as detailed in the works approval supporting documentation. The Delegated Officer's assessment of the current application has had specific regard to the independent verification that the design principles of TSF2 have been achieved. In this regard quality assurance testing was performed throughput the TSF construction process using an independent third party auditor (Coffey Services Australia Pty Ltd) and through use of an in-situ laboratory established at the site to ensure the starter embankment has met all of the

engineering design specifications. A certificate of compliance was submitted along with the supporting documentation signed by both the manager of the premises and the principle consultant design engineers indicating TSF2 has been construction in accordance with the design documentation and that the nationally recognised TSF design standards and principles have been adhered to (Guidelines on the safe design and operating standards for tailings storage 2017, DMIRS) allowing for the ongoing operation of the TSF in accordance of these guidelines.

During operation, tailing will be disposed along the perimeter embankments through sub-aerially rotating spigots, situated approximately 20m apart. Deposition will be managed to form a beach and a natural decline towards the center of each cell and a central decant tower which will pump and transfer the decant water to the return water pond via the causeway situated along the northern side of each cell. A total (operational and beach) freeboard of 500mm will be maintained at all times while allowing for a 1 in 100-year annual recurrence interval (ARI) rainfall event of 178mm over a 72 hour period.

TSF2 starter embankment and base was designed using a clay liner derived from the naturally low permeability *insitu* clays overlaid with 6.3km of slotted under drainage network to limit the movement of decant water trapped in the consolidated tailings mass and mounding beneath the TSF. The starter embankment was built to 355m RL (Reduced Level) and each subsequent 2.5m embankment lift will be constructed using the upstream method of construction for a total 6 stages to a final height of 370mRL. The embankments will be constructed using borrow material and mine waste that is tested to meet specified performance criteria. Eight piezometer arrays will be used to monitor the phreatic surface within the perimeter embankments, and a system of seepage interception trenches, cut off trenches will be used to further limit the movement of seepage into groundwater where it may impact on vegetation within proximity to TSF2. Groundwater monitoring from newly constructed bores will be managed via the Seepage Management Plan which was required to be submitted as part of the works approval compliance documentation.

This amendment considers the consequence and likelihood of emissions and discharges from TSF2 during operation and specifically potential impacts to soil, groundwater and native vegetation that may occur through rupture of pipelines, leachate through the base of the TSF, tailings release from over topping and contaminated stormwater runoff.

Following construction, the engineering and geotechnical stability of the TSF2embankments are managed through ongoing audits from the Department of Mines, Industry Regulation and Safety (DMIRS) and as such are not included in this assessment. These aspects of the premises are covered by Mining Proposal Registration ID 71009.

2.2 CEO initiated amendment

The CEO has also extended the duration of the Licence for a further six month period from 7 October 2019 to 7 April 2020 in accordance with *Guidance Statement: Licence Duration* to allow for continued operation through the remainder of this year and to allow the renewal of Mining Lease M27/245 which expires on 20 June 2020.

The CEO initiated an amendment to the type and style of the licence during June 2019 and has issued a revised licence incorporating all of the recent amendment notices. The obligations of the Licensee have not changed in making this amendment. During the consolidation of amendment notice/s; DWER has not undertaken any additional risk assessment of the Premises.

The CEO has:

- incorporated the Amendment Notices #1, 2, 3 and, 4 issued between 2017 and 2019 respectively and as listed below in the instrument log table;

- updated that style and appearance of the Licence;
- deleted the redundant AACR form set out previously in schedule 2 of the Licensee is advised to obtain the form from the Department's website;
- corrected clerical mistakes and unintentional errors

Amendment Notices 1-4 are located in Attachment 1 of this decision Report.

2.3 Amendment history

Table 2 provides the amendment history for L5029/1992/11.

Table 2: Licence amendments

Instrument	Issued	Amendment
L5029/1992/11	02/06/2016	Licence amendment to allow construction of TSF1 embankment rise of 2m.
L5029/1992/11	15/07/2016	Licence amendment to allow the dewatering and transfer of tailings supernatant from Waldon Pit to the Consols Pit and Ballarat Last Chance Pits.
L5029/1992/11	25/08/2016	Licence amendment to allow Waldon Pit to be converted into an In-pit TSF. Removal of *category 85: sewage facility* as throughput capacity of the wastewater treatment plant is less than the prescribed minimum requiring registration.
L5029/1992/11	28/7/2017	*Amendment Notice 1* - to include mining tenement M27/123 be included in the premises
L5029/1992/11	7/12/2017	*Amendment Notice 2*– to increase the throughput of ore processing from 2,000,000 to 2,500,000 tonnes per annum
L5029/1992/11	17/9/2018	*Amendment Notice 3* – amendment to extend the duration of the Licence to 7/09/2019
L5029/1992/11	8/10/2018	*Amendment Notice 4*– Amendment to correct an administrative error in Table of the amendment.
L5029/1992/11	27/09/2019	Amendment to licence for the operation of TSF2 following completion of works associated with W6125/2018/1; removal of decommissioned monitoring bores and the TSF1 decant pond; inclusion of new monitoring bores and TSF2 decant pond; amendment to the frequency of monitoring of bores surrounding the TSF's that are no longer used. The Amendment includes a CEO initiated consolidation of Amendment Notices 1-4 into the Licence and an amendment to extend the duration of the Licence by six months. During the consolidation DWER has not undertaken any additional risk assessment.

3. Other approvals

The Licence Holder has provided the following information relating to other approvals as outlined in Table 3.

Table 3: Relevant approvals

Legislation	Number	Subsidiary	Approval
Mining Act (WA) 1978	Reg ID 71009, 20 March 2018	Northern Star (Kanowna) Pty Limited	Approval for the construction and operation of TSF2
Dangerous Goods Safety Act 2004	Dangerous Goods Licence DGS012576	Northern Star (Kanowna) Pty Limited	Dangerous goods storage and handling
Part IV of the EP Act (WA)	Statement Number 331	Peko Gold Ltd	Operation of the Gold Roaster to treat refractory ore at the Kanowna Belle Gold Mine
Part V of the EP Act (WA)	L5029/1992/11	Northern Star (Kanowna) Pty Limited	Licence of emissions and discharges from the prescribed activities at the Kanowna Belle Gold Mine
Granted under section 51E of the EP Act	Clearing Permit CPS 7808/1	Northern Star Resources Ltd	Allows for clearing of up to 300Ha for the purpose of mining and related activities
Rights in Water and Irrigation Act 1914	GWL 62498(6)	Northern Star (Kanowna) Limited	Allows for dewatering of up to 3,030,000kL from the Paleaochannel- fractured rock aquifer.

4. Location and receptors

The Kanowna Belle Gold Mine is suitable approximately 18km north east of Kalgoorlie within the Goldfields region. Situated on the Yilgarn Craton, the area is mineral rich and has some of the largest known gold deposits found anywhere in the world. The region is arid, and although freshwater is scarce, the area has a rich biodiversity containing many endemic fauna and flora species (Botanica, 2017).

Table 4 below lists the relevant sensitive land uses in the vicinity of the Prescribed Premises which may be receptors relevant to the proposed amendment.

Table 2: Receptors and distance from activity boundary

Residential and sensitive premises	Distance from Prescribed Premises
Residential Premises-	The Ninga Mia Aboriginal Community is located approximately 15km east of TSF2 The city of Kalgoorlie is approximately 18.5km south west of TSF2

Table 5 below lists the relevant areas of high conservation value and special significance that may be impacted as a result of activities at or Emissions and Discharges from the Premises. The distances to specified ecosystems are shown in Table 6.

Table 3: Environmental receptors and distance from activity boundary

Environmental receptors	Distance from Prescribed Premises
Threatened Ecological Communities and Priority Flora	Priority 1 Flora 3.8km north of TSF2

4.1 Groundwater and water sources

Groundwater at the premises is hypersaline and the nearest wetlands are a salt lake system some 5.5km to the north as indicated in Table 6.

Table 4: Groundwater and water sources

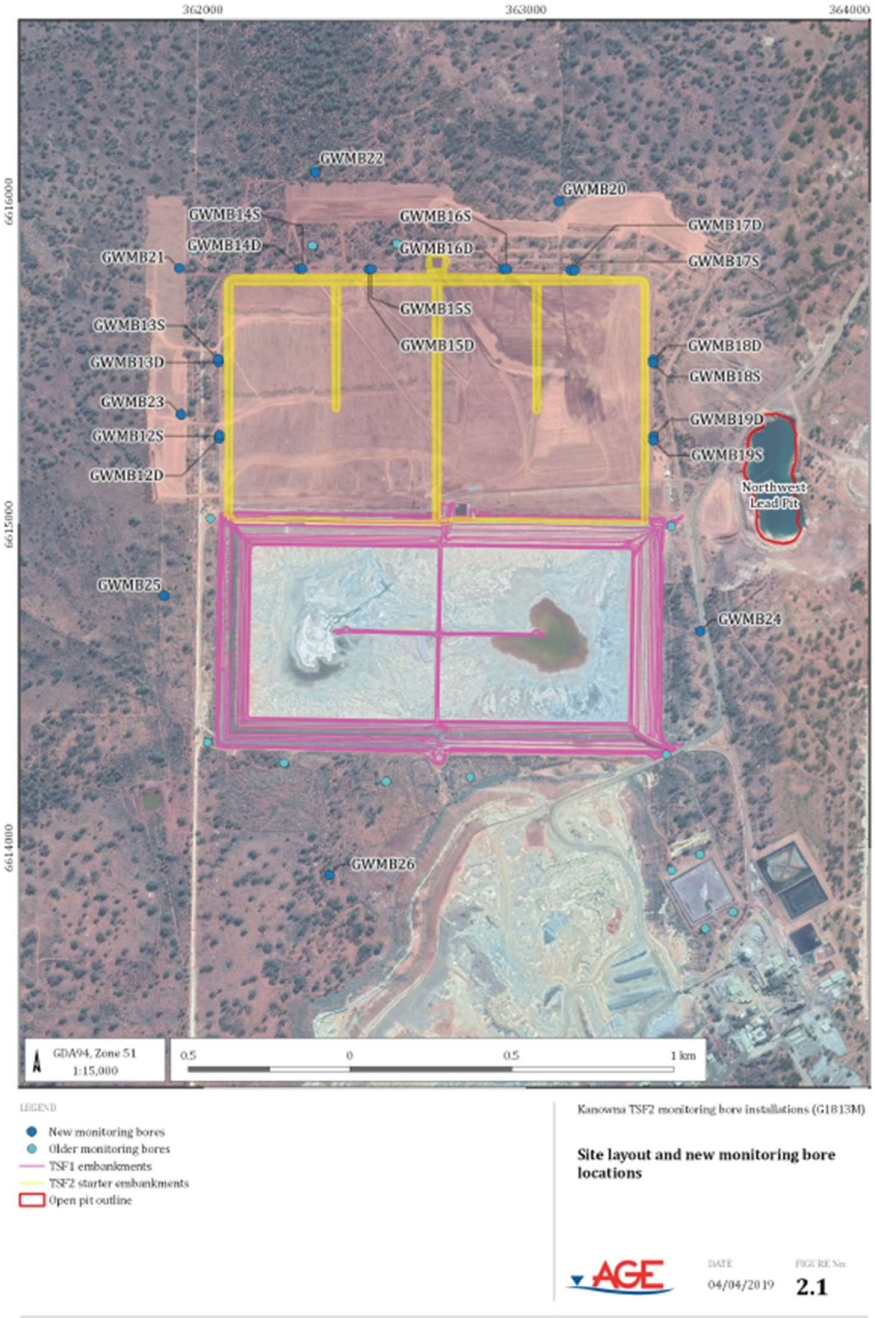
Groundwater and water sources	Distance from Premises	Environmental value
Major waterbodies	Salt lakes system 5.5km north	Likely ecological value will include localised bacteria, insects, birds and fringing vegetation.
Groundwater	The premises lies within the Goldfields Groundwater Area Proclaimed under the *Rights in Water and irrigation Act 1914* Historical baseline monitoring in the vicinity of TSF2 at the time TSF1 was constructed of TSF1 indicated a depth to the shallow aquifer of approximately 12mbgl. Bore construction as part of W6125/2008/1 indicates shallow groundwater from mounding is currently between 4.5mbgl and 8.0m below ground level underneathTSF2.	Groundwater in the area is naturally hypersaline and is not suitable for supporting flora or fauna. It has a naturally low pH, high TDS. Elevation or mounding due to seepage has the ability to affect localised vegetation growth where the groundwater reaches the root zone of plant species which in the Eastern Goldfields Region generally extend up to 6m below the ground surface.

Ground water mounding has historically been managed through a network or monitoring bores, seepage recovery bores and vegetation monitoring at the premises. Through the completion of works under Works Approval W6125/2018/1, the groundwater monitoring network has been amended by the decommissioning of monitoring and seepage recovery bores within TSF2 footprint area and the inclusion of an additional 15 monitoring sites surrounding TSF2. During construction of the monitoring bores, the Licence Holder constructed additional monitoring bores at eight locations to allow for paired bores capable of simultaneously monitoring shallow and deep groundwater monitoring as shown in Figure 1 below. This paired bore construction was undertaken to allow a more comprehensive understanding of the horizontal and vertical movement of groundwater and seepage through the complex geology beneath TSF2 which consists of paleo channel clays and a mottled pallid zone which extends up to 70m deep before reaching the deep bedrock.

The bore logs from the newly constructed wells show that surface geology consists of low permeability clay above some higher permeability lenses (typically occurring between 6-14mbgl) with the exception of the north eastern corner of the TSF where the higher permeability soils are closer to the ground surface (AGE, 2019a). The Seepage Management Plan (AGE, 2019b) submitted as part of the current application provides a review of historical groundwater monitoring and notes that the mounding from TSF1 has been significant and the seepage recovery has been effective in lowering groundwater levels. Analysis of groundwater chemistry indicates that while there are impacts such as significant increases in salinity (TDS) and a reduction of pH; the lack of cyanide (expressed as WAD-CN) indicates that seepage recovery has been effective and that cyanide is breaking down naturally within the soil horizon and that at least some of the mounding may be due to the physical effects of TSF1 obstructing surface drainage and shallow groundwater flow.

The Seepage Management Plan notes that although the liner and seepage recovery system for TSF2 is superior and the overall volumes of seepage are expected to be significantly less over the life of TSF2 when compared with TSF1. However as the groundwater is already elevated particularly closer to the north eastern corner, it is recommended that the monitoring of any additional mounding needs to be regular and responded to in a timely manner to prevent vegetation deaths, surface flooding and embankment stability as there is already a significantly reduced distance between the top of the top of groundwater table and the base of TSF2 (4.5m) when compared to when deposition commenced into TSF1 in 1993 and groundwater was at between 12-14mbgl (AGE, 2019b). .

Figure 1: New groundwater monitoring bore locations surrounding TSF1 and TSF2



Source: Figure 2.1: Kanowna Belle Mine TSF2 Monitoring Bore Installationt (AGE, 2019b)

Although there are no natural surface water resources with the premises boundary, there are a number of historical mining voids which have a lake like appearance from aerial imagery due

4.2 Meteorology

Rainfall and temperature

The Kanowna Belle Gold Mine is located in a semi-arid part of Western Australia which is characterised by very hot summers and cool winters. Rainfall on average is low (average of 266mm) however it is not uncommon for annual rainfall to vary between 110mL and 530mL (Weatherzone, 2018). Rainfall is evenly distributed throughout the year (3-4 days per month) and spring tends to tends to be the driest part of the year with the highest rainfall occurring during summer, driven by cyclonic weather patterns in the north of the state. Rainfall generated by the cyclonic systems tends to occur in short sharp bursts where large volumes are experienced over short timeframes which can lead to flood events.

The Premises receives most of its rainfall during the summer months and has its own weather monitoring station. The average rainfall recorded is 274mm per annum averaged over the period from 2006 to 2017 (NSR, 2018a). According to the Bureau of Meteorology the closest active weather station to Kanowna is one located at the Kalgoorlie-Boulder Airport. The average annual rainfall is 266.9mm and the mean evaporation is approximately 2,628mm per annum at this location (BOM, 2017).

5. Risk assessment

Table 8 below describe the Risk Events associated with the amendment consistent with the *Guidance Statement: Risk Assessments*. This table identifies whether the emissions present a material risk to public health or the environment, requiring regulatory controls

Table 5: Risk assessment for proposed amendments during operation

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		**Potential emissions**	**Potential receptors**	**Potential pathway**	**Potential adverse impacts**		
Tailings Deposition into TSF2	Tailings surface	Dust	No residences or other sensitive receptors within 15km of TSF2 Nearby native vegetation	Air / wind dispersion	Human health and amenity. Potential suppression of photosynthetic and respiratory functions	No	No residences or sensitive land uses within 15km of the premises so minimal to impacts are expected No impacts evident on native vegetation from existing activities. There is no record of Declared Rare Flora within 3.5km of TSF2.
	Tailings delivery and return water pipelines	Rupture of pipeline causing tailings discharge to land	Native vegetation and soil adjacent to tailings pipeline alignment	Direct discharge	Soil contamination inhibiting vegetation growth and survival	Yes	See detailed assessment below
	Seepage	Leachate	Soil and groundwater	Direct discharge	Groundwater mounding Groundwater contamination	Yes	See detailed assessment below
	Overtopping of TSF2	Tailings release	Native vegetation and soils	Overtopping of supernatant pond or tailings release during extreme rainfall event	Soil contamination. Impacts to terrestrial vegetation and ecosystems. Seepage leading groundwater contamination	Yes	See detailed assessment below
	Stormwater runoff	Stormwater contaminated with tailings and tailing liquor	Soils and vegetation within the stormwater catchment area	Sheet runoff and infiltration	Soil contamination inhibiting vegetation growth and survival	Yes	See detailed assessment below
Return water pond compound	Cyanide destruction plant	Hydrogen peroxide spills and breach of containment	Soil and vegetation adjacent to storage and pumping areas	Direct discharge, stormwater runoff	Soil contamination inhibiting vegetation growth and survival	No	The cyanide destruction plant and infrastructure existed previously and will be relocated. If build to the design specifications as outlined in the application represents no

Risk Events						Continue to detailed risk assessment	Reasoning
Sources/Activities		Potential emissions	Potential receptors	Potential pathway	Potential adverse impacts		
	Seepage	Leachate	Native vegetation and soil adjacent to return water pond	Direct discharge	Groundwater contamination	No	change to the overall risk profile of the premises

5.1 TSF2 pipeline failure

Risk assessment

There is potential for the discharge of tailings or return water to the environment through pipelines failing, bursting or leaking.

Tailings slurry and decant water contain soluble metals and metalloids (other chemicals) which are toxic to vegetation and fauna.

Overflow of tailings and decant water may cause vegetation and faunal death through contact with soft tissues such as through absorption or ingestion. Discharges of significant quantities tailings and return water may cause contaminants to seep into the soil profile and in significant quantities impact on the roots of deep rooted vegetation such as tree species and diminish ambient groundwater quality.

The relevant land and groundwater criteria include for discharges is the Guidelines for fresh and marine waters (ANZECC and ARMCANZ, 2000), and the National Environmental Protection (Assessment of Site Contamination) Measure (NEPC, 2013) for soil and groundwater.

The TSF has been designed and constructed in accordance with the *Code of practice: tailings storage facilities in Western Australia* (DMP, 2013) and the *Guidelines on Tailings Dams Planning, Design, Construction, Operation and Closure* (ANCOLD, 2012)

Leakage and failure of tailings and decant water pipelines will be managed through the use of an automatic leak and flow rate detection system, shut off valves, a standby pump, regular inspections, regular maintenance and the bunding of pipelines in open trenches. An operating manual has been provided for TSF2 and includes inspection of tailings and decant lines during each shift, twice daily (Coffey, 2017).

The Delegated Officer has considered the location of TSF2, the composition of tailings and decant water and that there are no declared rare flora or priority communities with 3.8km of TSF2 and determined that a tailings spillage would result in low level on site impacts. Therefore, the Delegated Officer considers the consequence to be **minor**.

The Delegated Officer has considered the infrastructure requirements for the TSF2 pipelines (tailings and return water) on the Existing Licence, distance to specified ecosystems; the impermeable nature of the insitu soils and determined that the environmental impact from a tailings/decant liquor spill to the environment will probably not occur in most circumstances. Therefore, the Delegated Officer considers the likelihood of the consequence occurring to be **unlikely**.

The overall rating for the risk of tailing and decant water spill through leaks, pipeline failure or rupture events during operation is **medium** and acceptable subject to regulatory controls.

Regulatory Controls

The Delegated Officer considers the following conditions are sufficient for managing the risks associated with TSF2 pipeline failure:

- Existing Licence Condition 1.3.1 requires all tailings delivery and return water lines to and from the TSF2 to be placed within secondary containment vessels to contain any spills. The pipelines are required to be fitted with a leak detection and automatic shut off system in the case of burst events.
- Existing Licence Condition 1.3.3 will be amended following completion of works to include TSF2 and the TSF2 decant pond containment infrastructure
- Existing Licence Condition 1.3.4 will be updated to ensure a 300mm operational freeboard

is maintained on TSF2 as well as other containment infrastructure.

5.2 TSF2 overtopping during operation

Risk assessment

Overtopping of TSF2 will occur if deposition into Cell 1 and Cell 2 exceeds the holding capacities of each cell, or as a result of a significant rainfall event, or a combination of both of these events. In the instance of an overtopping event, tailings slurry and decant water contain soluble metals and metalloids (other chemicals such as cyanide) which are toxic vegetation and fauna would be discharged to the environment leading to soil contamination and possibly impacts to terrestrial ecosystems, such as plant and animal deaths. Large discharge volumes or discharge over sustained periods could result in eventual groundwater contamination.

The risks of an overtopping event would be assessed against relevant land and groundwater criteria include the Guidelines for fresh and marine waters (ANZECC and ARMCANZ, 2000), and the National Environmental Protection (Assessment of Site Contamination) Measure (NEPC, 2013) for soil and groundwater.

The design and operation standard for TSF's is the *Guidelines on Tailings Dams Planning, Design, Construction, Operation and Closure* (ANCOLD, 2012) and the *Code of practice: tailings storage facilities in Western Australia* (DMP, 2013). The Code requires a minimum operational freeboard of 300mm to be maintained as well as a 200mm tailings beach freeboard (a total of 500mm). A combined freeboard of 500mm will be maintained at all times during normal operations which is easily able to accommodate rainfall from a 1 in 72 hour ARI event which is predicted to result in a 178mm raise within the TSF.

The method of tailings storage will create a depressed truncated prism over the area of TSF2 to ensure drying of the tailings and to facilitate removal of decant water. The depressed area will also allow for the temporary storage of volumes of storm water away from the perimeter embankments where it can impact on embankment stability (which is managed under the *Mining Act 1978*). The Operating Manual proposes a 30 days upper timeframe for removing excess storm water from a TSF following an extreme rainfall event.

The primary control methods used to prevent overtopping are the design specifications; the Operating Manual which includes freeboard markers, routine inspections (twice daily); regular maintenance; and minimizing the size and extend of a centrally located decant pond and to ensure maximum water is returned to the plant. The design features include the construction of cut off trenches adjacent to the upstream edges of the perimeter starter embankment, a sloped embankment crest, placement of rocks on the outer embankment for erosion control and operation of central decant tower.

If an overtopping event occurs, the Delegated Officer has determined that the impact of tailings and decant water discharge will have will have mid-level onsite impacts. Therefore, the Delegated Officer considers the consequence of an overtopping event to be **moderate.**

The Delegated Officer has considered the controls in place for TSF2 including embankment freeboard, capacity to accommodate a 1 in 100 years 72 hour rainfall event, design and infrastructure requirements as well as operational procedures as specified in the operations manual and determined that while overtopping of TSF2 will only occur in exceptional circumstances, impacts could occur if overtopping occurs. Therefore, the Delegated Officer considers the likelihood of the consequence occurring to be **possible**.

The overall rating for the risk of overtopping of TSF2 on environmental receptors during operation is **medium** and acceptable subject to regulatory controls.

Regulatory Controls

The Delegated Officer considers the following conditions are suitable for managing the risks associated with overtopping of TSF2 and the return water pond:

- Existing Licence Conditions1.3.3 will be amended following satisfactory completion of works to include reference to TSF2 in the *Operating Manual- KB TSF1 at Kanowna Belle Gold Mine*.
- Existing Licence Conditions 1.3.4 will be amended following satisfactory completion of works to include reference to TSF2. It requires maintenance of a 300mm minimum operational freeboard at all times;
- Existing Licence Condition 1.3.10 will be updated to require visual inspection of TSF2 (within Table 1.3.3)

5.3 TSF2 seepage during operation

Risk assessment

Seepage from the base of the TSF2 liner has the potential to cause groundwater contamination and mounding beneath TSF2. Groundwater beneath the TSF2 footprint area is hypersaline and the only beneficial use for the water in the area is as a process water supply for the processing of ore in mining operations. The depth to groundwater varies from 3.5-8mbgl which is higher than baseline data (~12mbgl) collected at the time the adjacent TSF1 was constructed. Seepage from TSF2 has the potential to further elevate groundwater levels and impact of the growth of vegetation. The root zone of plant species typical of the Eastern Goldfields Region generally extend to 6m below the surface and as the seepage is toxic to vegetation.

A geotechnical investigation was conducted by Coffey (2017) and found that the natural soil permeability at the site is low (at least 7.9 x 10^{-7}m/s at 15mbgl) and HDPE lining of the facility was not considered necessary as the clay soils will act as an aquitard. TSF 2 will have a clay liner comprised of in-situ soils and with a permeability of 1 x 10^{-6}m/s. The tests undertaken by Coffey (2017) also revealed that some sand (up to 33%) and gravel lenses (up to 10%) occur within the upper soil profile (from 2-15mbgl) meaning that any seepage through the base of the liner would impact on the shallow aquifer and vegetation within proximity to TSF2.

Seepage modelling undertaken by Coffey (2017) suggests that the seepage flux through the base of TSF2 will be in the order of 120m^3/day (starter embankment) and 405m^3/day (final embankment) during the design life of this facility. This rate of seepage has the potential to adversely affect groundwater quality and cause mounding if the base of the TSF is not engineered to have a low hydraulic conductivity and an underdrainage system.

TSF 1 currently causes localised mounding, including within the TSF 2 footprint area. A seepage recovery network exists in the vicinity of TSF1 to manage this mounding and 7 of the seepage recovery bores were decommissioned as part of the construction works for TSF as they were located within the TSF footprint area. In addition the Licence Holder has confirmed that 75 historical exploration bores and 10 groundwater monitoring bores have been decommissioned within the TSF2 footprint area (Topdrill, 2018) to prevent these bores acting like a direct conduit for seepage to the groundwater table.

Groundwater levels along the northern boundary of TSF1 and within the TSF 2 footprint area were recorded as between 3.45mbgl (GWMB04) and 5.07mgbl (GWMB07) in January 2018. The addition of seepage from TSF2 to that already present from TSF 1 is likely to further increase mounding.

The Licence Holder has constructed 15 new seepage recovery and monitoring bores around TSF2. Eight locations have paired bores to allow a more comprehensive understanding of the

horizontal and vertical movement of groundwater and seepage through the complex geology beneath TSF2.

The relevant land and groundwater criteria include for discharges within the 6m root zone of vegetation is the Guidelines for fresh and marine waters (ANZECC and ARMCANZ, 2000), and the National Environmental Protection (Assessment of Site Contamination) Measure (NEPC, 2013) for soil and groundwater.

To reduce the risk of seepage the following chave been incorporated into the TSF2 design:

- Decommissioning of bores within the TSF2 footprint area to prevent and block potential seepage pathways to groundwater;
- Construction of a cut off trench beneath and in the centerline of the external perimeter embankment to a depth where low permeability materials are encountered. This will act as a hydraulic barrier and prevent horizontal flow of seepage from within TSFT to the external environment. This will be particularly effective where sandy or gravelly soils are present;
- *Insitu* clay will be compacted for the base of TSF2;
- An underdrainage system comprised of approximately 6.3km of network of finger drains has been constructed along the clay base of the 100Ha TSF base and to collect seepage;
- A toe drain has been constructed along the external perimeter to capture seepage from the underdrainage system and near ground surface seepage. Collected seepage will drain to a toe drain sump and be pumped to the return water pond;
- Eight piezometer arrays have been constructed along the perimeter embankments to allow for early detection of seepage within the embankments. Each array will include three piezometers: one within the center of the embankment, and two either side of the embankment upstream and downstream of the tailings deposition;
- Decant structures have been constructed in the center of each TSF2 cell to maximize the recovery of process water;
- Tailings will be discharge conducted in a manner that ensures process water is constantly positioned around the central decant structure ensuring ponding is kept away from the perimeter embankments.
- Groundwater regularly monitored through 23 bores (15 locations; 8 paired bores).
- The 50m x 50m return water decant pond is HDPE lined
- Regular inspection and maintenance as proposed in the TSF Operating Manual (Coffey, 2017)

The Delegated Officer has considered the sitting of TSF2 and the low permeability soils within that location, the poor groundwater quality and relatively short distance to groundwater and determined that mid-level on site impacts will result from basal discharge from the TSF2 liner. Therefore, the Delegated Officer considers the consequence to be **moderate**.

The Delegated Officer has considered the design and construction standards of TSF2 including an underdrainage system, the operational procedures for management of TSF2, the proposed groundwater monitoring strategy and the natural low permeability of the *insitu* soils and determined that the impact of seepage will probably not occur in most circumstances. Therefore, the Delegated Officer considers the likelihood of the consequence occurring is **unlikely**.

The Delegated Officer considers the overall rating for the risk of seepage from TSF2 during operation is **moderate**, and acceptable subject to regulatory controls.

Regulatory Controls

The Delegated Officer considers the following conditions are suitable for managing the risks associated with seepage through the TSF2 liner:

- Existing condition 1.3.6 will be updated to include reference to TSF2 within the Seepage Management Plan.
- Existing Condition 1.3.10 (Table 1.3.3) will be updated to include regulation visual inspection of TSF2 embankment walls for seepage; regular monitoring of the piezometer arrays within the embankment walls and visual inspection of the ground surface for ponding near the north eastern corner of TSF2 were the groundwater is shallowest and where flooding/seepage is most likely to have an impact on the stability of the TSF following high intensity rainfall periods.
- Existing Conditions 3.5.1 will be updated to remove reference to decommissioned bores and include reference to the new groundwater monitoring and seepage recovery bores.
- Existing Condition 3.5.1 will be updated to reflect the changes to the groundwater monitoring regime as reflected in the new Seepage Management Plan, including the change from quarterly to monthly monitoring of bores surrounding TSF1 (previously monitored quarterly).

5.4 Contaminated Stormwater Runoff TSF2 during operation

Risk assessment

Stormwater runoff from TSF2 has the potential to become contaminated with sediments from tailings slurry, decant liquor, hydrocarbons, heavy metals, metalloids and hazardous chemicals and wastes during operation. Sodium cyanide forms metal complexes which are toxic and highly soluble in water. This can lead to contamination of land through direct contact and infiltration into soils. Soil contamination may inhibit vegetation growth and cause health impacts to fauna and through bioaccumulation in the food chain. Groundwater may also be contaminated because groundwater in the vicinity of TSF2 is relatively shallow (3.5mbgl-8.5mbgl).

The premises is located in a semi-arid region and rainfall at the premises characterised by short duration high intensity rainfall which has the potential to be contaminated by any spillage that has not been cleaned up, mobilising the contaminants within the premises leading to the spread of localised contamination. Thirteen catchment areas and subareas drain towards the TSF1 and TSF2. There is the potential for cyclonic rainfall to release 186mm of rain in a 1 in 100 ARI over a 72 hour period over a catchment area of approximately 100km^2 causing flooding around the base of the TSF and associated infrastructure including toe drains, culverts and the return water pond. There is currently a series of stormwater diversion drains constructed around TSF which deflects surface runoff around and away from the TSF and associated infrastructure.

The primary control mechanism for managing contaminated stormwater runoff is to limit contact of surface runoff with the TSF and associated infrastructure following extreme rainfall events. The flood modelling study indicates that the following design and operation considerations will have the effect of isolating the TSF2 from flood conditions:

- Construction of seepage trenches and toe drains around the external embankment perimeter of the new TSF;
- an extension to the existing western diversion drain and levee which will divert storm water around the TSF2 as well as TSF1 to divert surface runoff from high intensity cyclonic rainfall events;
- repair of existing levee and diversion drain, maintenance and cleaning debris out of

drains and culvert where required to allow clear passage of storm water.

The Delegated Officer has considered the location of TSF2 within the catchment drainage areas, the possibility of severe weather events, the solubility and toxicity of potential contaminants and the existing drainage systems and levees around the TSF1 and determined that storm water runoff from an extreme weather event could result in mid-level on-site impacts. Therefore, the Delegated Officer the consequence to be **moderate.**

The Delegated Officer has considered the extension to the existing western drain, the construction of toe drains and seepage trenches around the TSF2 embankment, maintenance works undertaken to existing drains and culverts (in addition to the spill management measures specified in the Operating Manual) and considers impacts from high intensity storm water runoff events will only occur in rare instances. Therefore, the Delegated Officer considers the likelihood of the consequence occurring to be **rare**.

The overall rating of the risk of seepage from the TSF (1 & 2) impacting on vegetation and contaminating soil to be **medium**, and acceptable subject to regulatory controls.

Regulatory Controls

The Delegated Officer considers the following condition 1.3.10 is suitable for managing the risks associated with overtopping of TSF2 and the return water pond:

- Existing Licence Conditions 1.3.10 (table 1.3.3) will be amended following satisfactory to include reference to the stormwater diversion culverts, drains and levee around the TSF2 to require regular inspection and maintenance of this infrastructure.

5.5 Request for additional changes to Licence Conditions

The Licence Holder has requested and the Delegated Officer has accepted the following changes to the Licence Conditions:

- A reduction in monitoring frequency of bores surrounding the calcine dam from monthly to quarterly. Deposition in to the calcine dam ceased many years ago and abstraction volumes from the seepage recovery bores have been described as “extremely low” (RPS, 2019) and ambient groundwater levels are dropping and are expected to continue to decline.
- A reduction in monitoring frequency of bores surrounding the Red Hill In-pit TSF Tailings deposition into the Red Hill In-Pit TSF ceased in 2017 and groundwater levels have gradually decreased over the last annual period as mounding reached a peak level and is expected to continue to decline until they reach the levels encountered before the mining void was converted into a TSF (RPS, 2019). Water abstraction was sufficiently low during the 2018 period that no samples were able to be taken from production bore BH1B. Production bore RHBH9 was unable to be sampled in April 2018 due to insufficient yield. The Red Hill In-pit TSF is still able to be used for the storage of supernatant water if required.
- A reduction in frequency of bores and standing water level monitoring around the existing Consols and BLC pits as they were used as intended for the storage of supernatant water from the Waldon Pit up until the end of 2017 if required. These voids have been used for this purpose during 2017 and the Licence Holder has specified that during periods when supernatant is transferred into these pits, groundwater monitoring will increase to monthly. The Consols and the BLC supernatant ponds will be tested 6-monthly instead of monthly to reflect the anticipated change in frequency of use of these pits.

The Delegated Officer has also considered the Licence Holders requests for that process monitoring condition 3.4.1 to be amended to require supernatant pond liquor testing to occur

from TSF 2. The Delegated Officer considers there is sufficient information available on supernatant liquor and the Licence Holder can monitor variations in liquor chemistry outside of the Licence Conditions. Any impacts on shallow groundwater chemistry will be observed through ambient groundwater monitoring data.

6. Licence Holder's comments

The Licence Holder was provided with the draft Amendment Notice on the 19 June 2019. The Licence Holder provided comments on the draft amendment and consolidated Licence on 26 June 2019. The comments received relate to typographical errors and a request to amend the required frequency for the visual inspection of stormwater diversions culverts, drains and levees from weekly to monthly in Table 1.3.3. The Licence holder advised that due to the low frequency of high rainfall events the inspection schedule was unnecessary. The Delegated Officer has conceded that monthly inspections will be sufficient to maintain these infrastructure and the build-up of vegetation and debris unlikely to be significant prior to rainfall events within a monthly period

Attachment 1: Amendment Notices # 1- 4